

July 31, 1934.

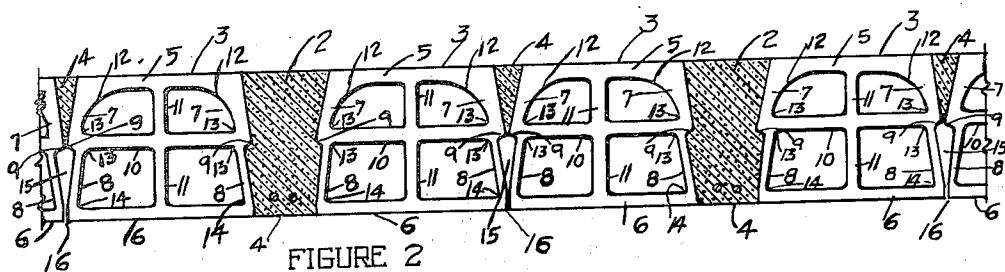
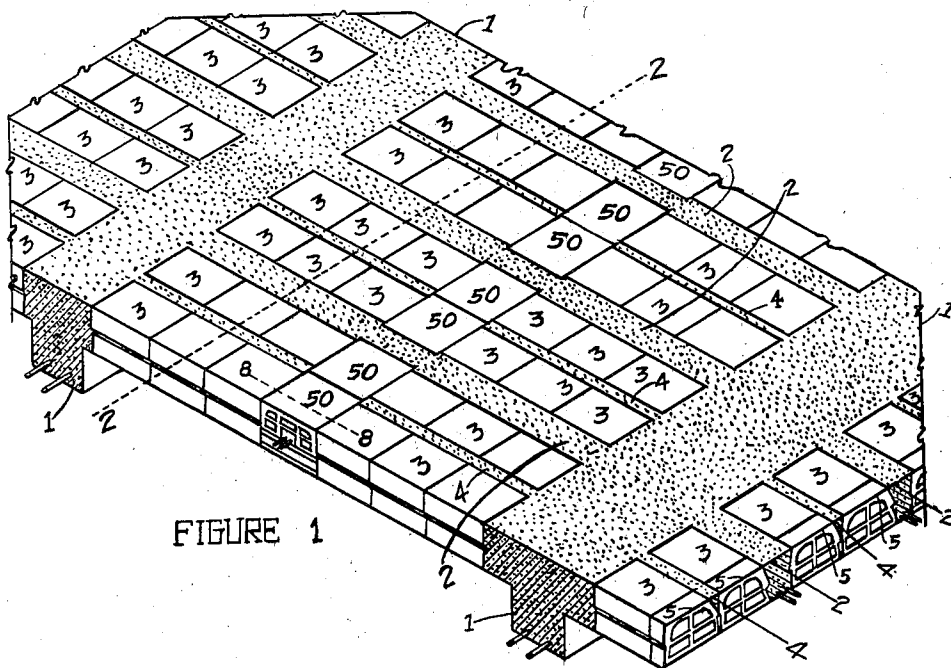
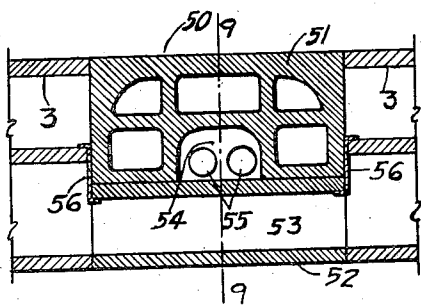
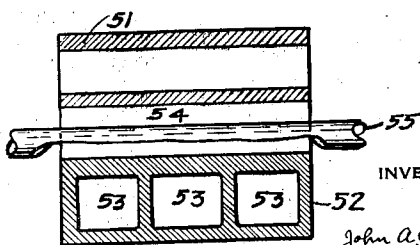
J. A. FERGUSON

1,968,034

FLOOR AND ROOF CONSTRUCTION

Filed Dec. 14, 1929

2 Sheets-Sheet 1



INVENTOR

John A. Ferguson
By
Richard E. Marine
His Attor.

July 31, 1934.

J. A. FERGUSON
FLOOR AND ROOF CONSTRUCTION

1,968,034

Filed Dec. 14, 1929

2 Sheets-Sheet 2

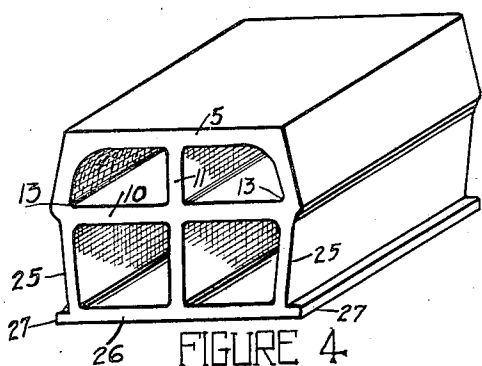


FIGURE 4

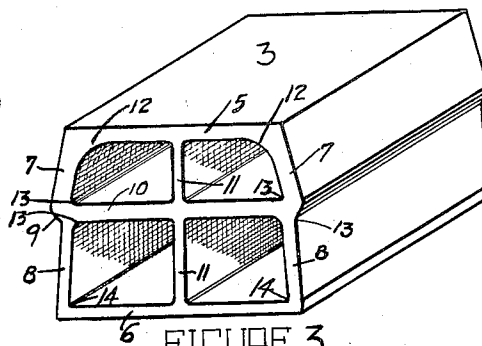


FIGURE 3

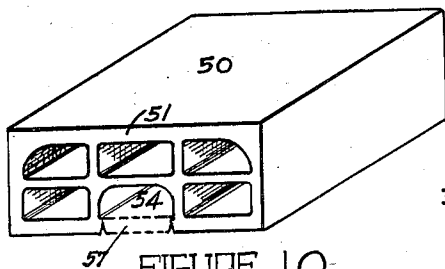


FIGURE 10

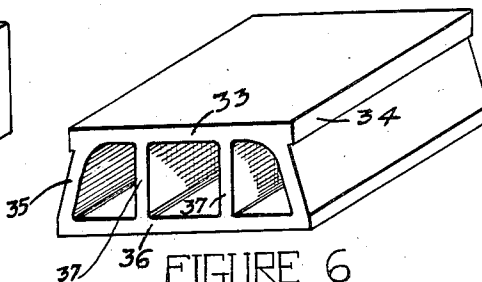


FIGURE 6

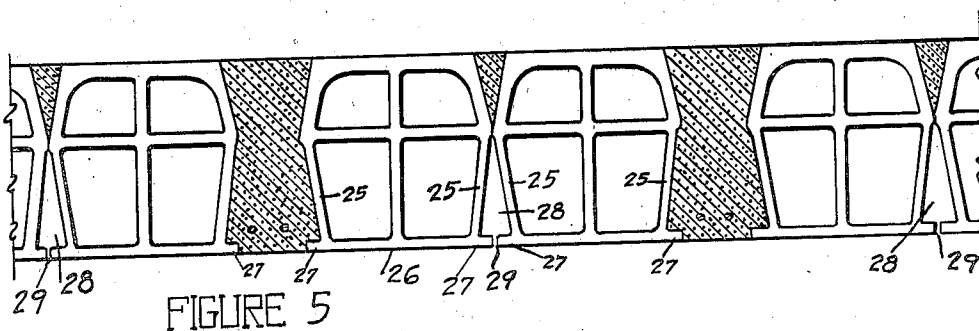


FIGURE 5

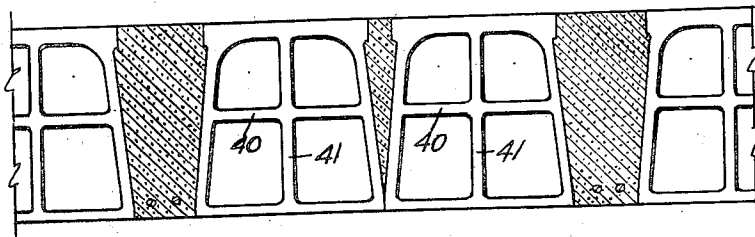


FIGURE 7.

INVENTOR

John A. Ferguson
By
Richard O. Marine
His atty.

UNITED STATES PATENT OFFICE

1,968,034

FLOOR AND ROOF CONSTRUCTION

John Ashley Ferguson, Pittsburgh, Pa.

Application December 14, 1929, Serial No. 414,052

17 Claims. (Cl. 72-66)

My invention relates to improvements in composite floor or roof constructions and to novel forms of hollow tiling for use therein.

More particularly, my invention contemplates a reinforced concrete and hollow tile construction in which a maximum of preformed tiling and a minimum of concrete, or the equivalent, is employed, preferably no concrete being used above the tiling, the parts being carefully proportioned to give the necessary strength at each point with a minimum of material, whereby a fireproof flooring of great simplicity, capable of being easily and speedily assembled, quick setting, of light weight, great strength and rigidity, expandable under the influence of great heat without breaking, and of low cost, is produced.

In prior practice where floor and roof constructions were made of flat top tiles without superposed concrete, or the like, it has been the common practice to locate the adjacent reinforced concrete joints sufficiently close together to permit the space between them to be spanned by a single tile, whereas in structures where this space was chosen sufficiently great to require two or more tiles arranged in series to span it, it has been the common practice to employ a superposed bed of concrete to lend strength to the structure and bind its parts together. In the first case excessive quantities of concrete were used by reason of greater number of joists employed, and in the second case excessive quantities were used in the superposed bed.

By my invention I overcome the defects of both of these constructions while securing the advantages inherent in each. On the one hand I dispense with the greater number of joists by employing two or more tiles in series between adjacent more widely separated joists and on the other hand I dispense with the necessity for the use of a superposed bed of concrete, or its equivalent, above the tiles and joists. This I accomplish by the use of a tile structure having its parts so proportioned and correlated to the tile or tiles of similar construction in series therewith and to the joists that the localized stresses, strains and shears always encounter material so disposed and proportioned and of such compressive, tensile, shearing and bonding strengths as to be adequately capable of sustaining them and transmitting them to the adjacent members, with a large factor of safety, the stress relationship between elements of the composite construction being dependent upon the relationship existing between their respective moduli of elasticity.

In the preferred embodiment of my invention I

provide between the flat top tiles bridging in series the space between adjacent joists, narrow, conveniently V-shaped, openings or spaces filled to the level of the tiles and joists with concrete or similar material whereby an exact fit is secured regardless of imperfections in the shape of the tiles. The joists are also preferably made relatively wider at their tops than at their bottoms because the compressive stresses in the concrete are greatest at their tops.

As a further important feature of my invention, of general utility, I provide each tile with a horizontal web, located substantially on the neutral axis of the floor or roof construction. This position of the horizontal web provides a new property therefor, viz., greater capacity to resist longitudinal horizontal shears which are greatest on the neutral axis. This web also transfers, by means of horizontal shears, forces to the opposite side of the tile away from the concrete joisted element, thus developing shears and compressive stresses in the oppositely placed top side shell which in turn develops compressive stresses in this opposite end of the top shell. This permits utilizing these side and top shells more fully to carry stresses, strengthens the construction and increases the efficiency of the system. Vertical webs may also be advantageously provided.

As a still further feature of my invention, also of general utility, I may provide a free opening or space between the bottoms of the tiles, to permit expansion therein of the lower portions of said tiles, in case of fire, to prevent crushing or breaking their adjacent lower corners. This opening may also be employed to receive and retain in its lower portion plaster from the ceiling to retain the latter in place. The opening may also be so shaped, within the spirit of my invention, as to serve as a conduit for electrical conductors, or the like. I also preferably make the lower side shells of my tiles of thinner construction than the upper portions, and inclined, to facilitate their bending in case of fire. This results also in a substantial saving of material and reduction in the dead weight. The outer faces of these shells are preferably inset from the outer faces of the upper side shells to constitute shoulders which serve to space adjacent tiles from each other and as anchors to secure the tiles firmly in the concrete joists. These shoulders are preferably located just below the neutral axis to provide a thickened portion for carrying stresses accumulating at the neutral axis.

As a further feature of my invention I preferably provide fillets in all of the corners but par-

particularly in the corners between the flat tops of the tiles and the adjacent top side shells to assist in carrying the accumulated shearing stresses under load which are greatest at the concrete
5 joisted element. The top and upper side shells are also preferably made relatively thick to resist the compressive and shearing stresses.

A further important feature of my invention consists in providing between the tiles bridging
10 the space between adjacent joists other tiles adapted to closely fit between said first mentioned tiles, but provided with cells at an angle to the cells in said first-mentioned tiles to serve as cross conduits for electrical conductors or the like.
15 These tiles may conveniently be made in two parts, the upper parts, preferably of my standard construction, being capable of use alone in thin floor structures, or with lower portions of graded thicknesses for thicker floors. These cross-wire
20 tiles, usually employed also in series relation, may engage the joists at their ends and may conveniently be braced at their intermediate portions by members, preferably stamped from sheet metal, supported from the adjacent floor structure.
25 Where a two-part tile is employed the lower part may be supported in this manner, the conductors then laid upon it, and the upper tile portion with open lower cell at its bottom, then placed thereover.

30 While I have shown the several features of my invention in cooperative relationships which give maximum efficiency, it is obvious that they may be advantageously employed severally in other combinations.

35 In the accompanying drawings, forming a part of this specification and showing for purposes of exemplification preferred forms and manners in which the invention may be embodied and practiced but without limiting the claimed invention to
40 such instance or instances:

Figure 1 is a perspective view of my floor or roof construction;

Fig. 2 is a vertical section on the line 2—2 of Fig. 1;

45 Fig. 3 is a perspective view of a detached tile of the character shown in Figs. 1 and 2;

Fig. 4 is a perspective view of a modified form of tile;

50 Fig. 5 is a vertical section similar to Fig. 2 but embodying the modified form of tile shown in Fig. 4;

Fig. 6 is a perspective view of a further modified form of tile;

55 Fig. 7 is a vertical section similar to Fig. 2 but embodying a still further modified form of tile;

Fig. 8 is a vertical section on the line 8—8 of Fig. 1, showing a form of cross-tiling adapted to serve as a conduit for electrical conductors or the like;

60 Fig. 9 is a vertical section on the line 9—9 of Fig. 8; and

Fig. 10 is a perspective view of the upper portion of the tiling in Fig. 8 showing the final step in its manufacture.

65 Referring to the drawings, there is shown in Fig. 1 a floor structure comprising spaced main supporting members 1, which may conveniently take the form of reinforced concrete girders, as illustrated, or steel girders, or the like, and at
70 regular intervals between these girders are located the joists 2, preferably of reinforced concrete. Spanning the space between two adjacent joists are the tiles 3, advantageously arranged in series of two, end to end, (although the number
75 may be varied within the spirit of my invention)

the extreme ends of a pair being supported by the respective joists and the adjacent ends of each pair being preferably separated by a key member 4 conveniently composed of concrete.

80 As shown in Figs. 2 and 3, each tile, 3, comprises a flat top shell, 5, bottom shell, 6, upper side shells, 7, lower side shells, 8, inset at their upper ends from the top shells, 7, to form rounded shoulders 9, a horizontal web, 10, and vertical web, 11. The top shell 5 and top side shells 7
85 are made relatively thick and strong, in order to enable them to carry their loads without the necessity of employing superposed concrete. Fillets 12 are also preferably formed between them and are designed of such strength as to transmit
90 horizontal and inclined shearing forces from the side shells 7 to the top shells 5 where they are transformed into compressive forces. Similarly, fillets 13 are formed between the horizontal web 10 and side shells 7 and 8, and fillets 14 are
95 formed between the bottom shell 6 and side shells 8. The horizontal web 10, which functions as a horizontal sub-girder, is located substantially on the neutral axis of the composite construction, as computed when all elements are contributing
100 their full theoretical effects, and is designed to resist efficiently those horizontal shears which are greatest at the neutral axis where bending or flexural stresses are at the minimum, this web thus serving to increase the rigidity of the struc-
105 ture and reduce the cumulative effects of such forces upon deflection. The shoulders 9 are located substantially at the neutral axis and provide an enlargement of the area of bonding contact between the concrete and the tiles, thus
110 reducing the unit stress in shear upon such contact surfaces while simultaneously providing, together with the fillets 13, an increase in cross-sectional area of the sides and web at this point, thereby effecting a reduction in the unit stresses
115 transferring shears in this region.

Referring more particularly to Fig. 2, it is seen that the shoulders of adjacent tiles abut at a point midway between the joists 2, thus serving as a bottom for the wedge-shaped concrete key
120 member 4, and preventing the concrete from falling into the space 15 below the same. They also serve to prevent the tiles falling away from the concrete joists. The concrete key members 4 completely fill the space above the shoulders
125 and compensate for any irregularities of the tiles, thus preventing any tendency for the latter to settle at this point.

The spaces 15 are formed between the lower-inclined side shells 8 and shoulders 9 and are
130 open at their lower ends, 16, between adjacent bottom shells 6, to permit the expansion of said bottom and side shells, in case of fire. The bottom and lower side shells are preferably made thinner than the top and upper side shells, the
135 lower side shells being inclined and made relatively long and the adjacent fillets being designed to cooperate therewith to permit differential expansion of the parts, when heated, without
140 breaking. The open ends 16 may also be utilized to receive portions of the ceiling plaster to retain the latter in place.

In Figs. 4 and 5 is shown a modified form of tile in which the lower side shells 25 are inclined
145 inwardly, the bottom shell 26 extending beyond the side shells to form ledges or shelves 27, two adjacent tiles forming the space 28 between them, and the ledges or shelves being spaced apart at 29, to permit expansion. The space 28 constitutes
150

a convenient conduit for electrical conductors, or the like.

In Fig. 6 is shown a further modification of tile in which the lower side shells and bottom shell of the former tiles are, in effect, omitted and the top shell 33 is extended to form a shelf or ledge 34 extending beyond the upper ends of the side shells 35, a bottom shell 36 and vertical webs 37 being also provided. This tile is of very simple construction, highly efficient, and is adapted for use where conditions are not too severe. Where a tile of greater strength is required, the tile of Fig. 6 may be modified, as shown in Fig. 7, by making it deeper and providing therein a horizontal web 40 and vertical web 41, as shown.

In Figs. 8, 9 and 10 is shown a form of cross-tile designed to carry electrical conductors, or the like, at an angle to their direction in the tiles 3, or joists 2, as the case may be. To this purpose, a pair of cross-tiles 50—50 in series relation may conveniently be designed to occupy the same space as that occupied by a pair of standard tiles 3—3, as shown in Fig. 1. The cross-tile 50 may conveniently comprise an upper portion 51 and a lower portion 52, as shown in Figs. 8 and 9, the lower portion conveniently comprising a tile provided with cells 53 extending in the same direction as the cells in the standard tiles 3. The upper portion 51 is also provided with cells, but these cells extend at an angle to the cells in the lower portion, being, in fact, shown at right angles thereto. The upper portion may conveniently be designed with a comparatively large central cell 54, provided with an open bottom, and through which conductors 55, or the like, may pass. In constructing the floor the lower portion 52 is conveniently first placed in position and held in place, preferably by sheet metal pieces 56, which are inserted between the ends of the lower portion and the ends of the adjacent tiles 3, the ends of the metal pieces being bent preferably over the central web of the tiles 3 and under the upper side of the tile portion 52. The conductors 55 may then be laid in proper position on the top of the lower portion and the top tile portion 51 placed there-above, the ends of the cross-tile portions being, of course, firmly seated in the adjacent joist members after the concrete is in place. Obviously where a floor of moderate thickness is employed, a single cross-tile member, similar to 51, corresponding to the thickness of the floor may be employed, its lower central cell preferably being closed at the bottom. This cross-tile member may be adopted as standard construction, and, where floors of greater thickness are employed, may be supplemented with a second cross-tile portion corresponding to 52, which may be made of different thicknesses to accommodate floors of different thicknesses.

As shown in Fig. 10, for convenience in molding the upper portion of the cross-tile, a temporary bottom may be provided for the lower central cell, as shown at 57, which bottom may be subsequently knocked out to provide an open bottom cell. The upper portion of the cross-tile is, of course, designed to carry the compressive forces transmitted thereto by the adjacent portions of the flooring or roof structure, just as in the case of the standard tiles 3.

It will be understood that in order to properly bond the concrete floor finish or plaster to the surfaces of the tiles with which contact is made, such contact surfaces may be roughened, scored or dove-tailed in the conventional manner.

While, in accordance with the provisions of the statutes, I have illustrated and described the best forms of my invention now known to me, it will be understood that changes may be made in the apparatus disclosed without departing from the spirit of my invention as covered by the claims, and that certain features of my invention may sometimes be used to advantage without a corresponding use of other features.

I claim as my invention:

1. In a composite reinforced concrete and hollow tile construction, in combination: joist members in spaced relation; a plurality of tiles between opposite points of consecutive joists having their tops in spaced relation; and concrete key members located in said last mentioned spaces, the tops of the joists, tiles and key members lying in the same plane and adapted to carry the compressive forces imposed by the load on the structural system.
2. In a composite reinforced concrete and hollow tile construction, in combination: joist members in spaced relation; a plurality of tiles between opposite points of consecutive joists having their tops in spaced relation and contacting at a point below the top; and concrete key members located in said last mentioned spaces, the tops of the joists, tiles and key members lying in the same plane and adapted to carry the compressed forces of the structural system.
3. In a composite reinforced concrete and hollow tile construction, in combination; supporting members in spaced relation and a plurality of tiles between opposite points of adjacent members; the upper and lower portions of adjacent tiles being normally spaced apart, and the intermediate portions of said tiles contacting with each other.
4. In a composite reinforced concrete and hollow tile construction, in combination; supporting members in spaced relation and a plurality of contacting tiles between opposite points of adjacent members, the lower portions of adjacent tiles being normally spaced apart.
5. In a floor or roof construction in combination; supporting members in spaced relation; hollow tiles in series between opposite points of said members, the upper portions of said tiles constituting the load compression portions, and the lower portions of adjacent tiles being separated by a free space and comprising members capable of expansion into said space, when heated, without breaking said tile.
6. In a floor or roof construction in combination; supporting members in spaced relation; hollow tiles in series between opposite points of said members, said tiles being provided intermediate their tops and bottoms with horizontal webs; portions of adjacent tiles below said webs being spaced apart and being relatively thinner than the portions of said tiles above said webs.
7. In a reinforced concrete and hollow tile construction: spaced joists; a plurality of hollow tiles between opposite points of adjacent joists provided with shoulders intermediate their top and bottom to prevent said tiles from falling away from said joists and for spacing the upper and lower portions of adjacent tiles from each other; and keys between the upper portions of adjacent tiles, the tops of said joists, tiles and keys lying in the same horizontal plane, and adapted to carry the compressive forces of the structural system.
8. In a reinforced concrete and hollow tile construction: spaced joists; a plurality of hollow tiles

in series between opposite points of adjacent joists, said tiles being provided with horizontal webs located substantially on the neutral axis of the composite structure for resisting the horizontal shears therein.

9. In a reinforced concrete and hollow tile floor construction in which the cells of the tiles normally extend in a given direction, a hollow tile designed to fit in said floor construction but having its cell or cells extending at an angle to said first named cells whereby conduits transverse to said first named cells are provided for the passage of electrical conductors and the like.

10. In the combination defined in claim 9, suspension members for supporting said tile member from adjacent floor members.

11. In a reinforced concrete and hollow tile floor construction in which the cells of the tiles normally extend in a given direction, a two-part tile construction designed to fit in said floor construction, said two-part tile comprising a lower member adapted to be first placed in position to maintain the adjacent parts of the floor in place, and an upper member having a cell or cells extending at an angle to said first mentioned cells whereby conduits transverse to said first mentioned cells are provided for the passage of electrical conductors or the like.

12. A two-part hollow tile construction comprising an upper member provided with an open bottom cell and a lower member adapted to con-

stitute a closure for said cell when the upper member is placed thereon, whereby a conductor or the like may be first laid upon said lower member and then enclosed by placing above it the open-bottom cell of the upper member.

13. A hollow tile provided with a horizontal web intermediate its top and bottom, the portions of said tile below said web being relatively thinner than its upper portions.

14. A hollow tile provided with relatively thick upper or load compression portions and relatively thin lower portions inset from the upper portions to permit expansion of the lower portions into adjacent free spaces without fracture when heated.

15. A hollow tile having its maximum width intermediate its top and bottom and the upper portion of a side sloping inwardly towards the top from said region of maximum width, the lower portion of the same side being inset inwardly on the line of maximum width and extending downwardly and outwardly to the bottom.

16. A composite concrete and tile construction comprising a plurality of tiles contacting each other at their intermediate points, the upper and lower portions of the tiles being normally spaced apart, and a concrete key member in the space between the upper portions.

17. In the combination defined in claim 15 a transverse web in the line of its maximum width.

JOHN ASHLEY FERGUSON.

35 110

40 115

45 120

50 125

55 130

60 135

65 140

70 145

75 150